

**AIR FORCE
PROPOSAL PREPARATION INSTRUCTIONS**

The responsibility for the implementation and management of the Air Force STTR Program is with the Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. The Air Force STTR Program Executive is R. Jill Dickman, (800)222-0336. **DO NOT** submit STTR proposals to the AF STTR Program Executive under any circumstances. Addresses for proposal submission and numbers for administrative and contracting questions are listed on the following page.

Technical questions may be requested using the DTIC SBIR Interactive Technical Information System (SITIS). For a full description of this system and other technical information assistance available from DTIC, please refer to section 7.2 of this solicitation.

Pre-Solicitation Announcements (PSA), listing the full descriptions of the topics and the author of each, were issued by the individual AF laboratories in electronic and hard copies, after being announced in the Commerce Business Daily. Contact the laboratories directly for information on future PSAs (see activity/ mailing addresses and phone numbers on the next page). Open discussions were held with the topic authors concerning technical aspects of the topics until this solicitation was released. Small businesses that did not know about the PSAs or did not participate in the exchange may find relevant questions or comments from these talks listed in SITIS.

For each Phase I proposal, send one original and three (3) copies to the office designated on the following page. Be advised that any overnight delivery may not reach the appropriate desk within one day.

Unless otherwise stated in the topic, Phase I will show the concept feasibility and Phase II will produce a prototype or at least show a proof-of-principle.

PROPOSAL SUBMISSION INSTRUCTIONS

<u>Topic Number</u>	<u>Activity/Mailing Address</u> (Name and number for mailing proposals and for administrative questions)	<u>Contracting Authority</u> (For contractual questions only)
AF 97T001 thru AF 97T006	Air Force Office of Scientific Research AFOSR/NI (Dr Jerome Franck) 110 Duncan Ave, Ste B115 Bolling AFB DC 20332-0001 (Dr Jerome Franck, (202) 767-4970)	Ernest Zinser (202) 767-4992
AF 97T007	Flight Dynamics Directorate Wright Laboratory WL/FIOP, Bldg 45 Wright-Patterson AFB OH (Madie Tillman, (513) 255-5066)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF 97T008	Manufacturing Technology Directorate 2977 P St, Ste 6, Bldg 653 Wright-Patterson AFB OH 45433-7739 (Marvin Gale, (513) 255-4623)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143
AF 97T009	Aero Propulsion & Power Directorate WL/POM 1950 Fifth St, Bldg 18, Rm 105A Wright-Patterson AFB OH 45433-7251 (Betty Siferd, (513) 255-2131)	Terry Rogers (513) 255-5830 Bruce Miller (513) 255-7143

AF STTR 97 KEYWORD INDEX

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AIR FORCE 97.1 TOPICS

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, BOLLING AFB DC

AF 97T001	High Frequency Electromagnetic Propagation/Scattering Codes
AF 97T002	Battlefield Chem/Bio Decontamination Using Atmospheric Discharge Plasmas
AF 97T003	Organic/Polymeric Electro-optical Materials and Devices
AF 97T004	Situation Awareness Based on Fusion of Data from Multiple Sources
AF 97T005	Micro Mechanical Inertial Platform System
AF 97T006	Development of High Temperature Solid Lubricant Coatings

WRIGHT LABORATORY - FLIGHT DYNAMICS DIRECTORATE, WRIGHT-PATTERSON

AFB OH

AF 97T007	Air Vehicle Technology
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WRIGHT LABORATORY - MANUFACTURING TECHNOLOGY DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF 97T008	Affordable Tooling for Composite Structures
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WRIGHT LABORATORY - AERO PROPULSION & POWER DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF 97T009	Characterization of Particle Damping for Gas Turbine Engine Blades
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AF 97T001 TITLE: HIGH FREQUENCY ELECTROMAGNETIC PROPAGATION/SCATTERING CODES

Category: Basic Research

OBJECTIVE: New approaches are sought for numerical implementations to the high frequency approximations to Maxwell's equations.

DESCRIPTION: The prediction of scattering attributes of actual-size Air Force inventory currently relies on that provided by the high frequency approximations to Maxwell's equations. Improvements in numerical implementations are sought which correctly predict the shadow boundaries, which effectively incorporate higher order correction terms, which incorporate the correct surface normals, and which contain rigorous error controls.

Phase I: Compelling new approaches are solicited which do some or all of the above improvements.

Phase II: A user-friendly commercially attractive code capable of handling airplane-sized objects.

POTENTIAL COMMERCIAL MARKET: An appropriate commercial application for demonstration of the Phase II goals is the prediction of comparability and interference for urban cellular phone usage.

REFERENCES:

E Fatemi et al, Jnl Comp Phys, Vol. 120, 143 (1995)

AF 97T002 TITLE: BATTLEFIELD CHEM/BIO DECONTAMINATION USING ATMOSPHERIC DISCHARGE PLASMAS

Category: Basic Research

OBJECTIVE: Innovative concepts. are sought to exploit the newly discovered capability of using atmospheric pressure glow-discharge plasmas to sterilize biologically contaminated surfaces.

DESCRIPTION: The decontamination of equipment and facilities that have been exposed to deadly biological and/or chemical warfare agents continues to be of utmost concern. Current techniques utilize high temperatures, strong chemicals, and/or ultraviolet radiation to sterilize contaminated items. All these approaches can require significant fractions of an hour to be effective over a limited amount of surface area. In addition, insulated chambers, toxic waste fluid, and eye damage hazard are respectively undesirable side effects of those techniques. In a combat situation, one prefers a self-contained system that is easy to use with no hazardous byproducts. Clearly, techniques that work in seconds rather than minutes or hours are also greatly preferred.

It has recently been demonstrated in university laboratories that materials exposed to a one-atmosphere-pressure glow discharge plasma can be sterilized of biological contaminants in under one minute. It seems likely that such a plasma could similarly neutralize some subset of chemical warfare agents as well. Such plasmas are simple to create, can be switched on-and-off, and produce no toxic byproducts. However, questions that remain to be answered include their effectiveness against a full range of chem/bio warfare agents as well as their optimization with respect to power consumption and field-portability. Possible interference with battlefield electronics must also be considered.

PHASE I: Design and fabricate a laboratory atmospheric glow discharge plasma decontamination apparatus which could be made field-portable. Demonstrate its effectiveness in rapid sterilization of simple biological contaminants. Prepare a comprehensive plan describing (1) how to make a system field-portable, (2) how to test the effectiveness of the plasma against a full spectrum of chemical and biological warfare agents, and (3) how to optimize the eventual proven system for battlefield use.

PHASE II: Fabricate a prototype field-portable atmospheric glow discharge plasma decontamination system. Test the effectiveness of the prototype system against a realistic spectrum of biological and chemical warfare agents.

Theoretically and empirically determine the lowest power requirements for effective operation. Demonstrate the clear superiority of the new system to any of the current decontamination systems.

POTENTIAL COMMERCIAL MARKET: If the viability of such a new decontamination approach is proven, it could revolutionize sterilization techniques throughout the entire civilian and military medical communities.

REFERENCES:

1. J.R. Roth, M. Laroussi, and C. Liu, Proc.IEEE Conf.on Plasma Sci., 170-171 (1992)
2. D.M. Sherman et al, Proc.IEEE Conf,on Plasma Sci., 175 (1996)

AF 97T003 TITLE: ORGANIC/POLYMERIC ELECTRO-OPTICAL MATERIALS AND DEVICES

Category: Basic Research

OBJECTIVE: Conduct research on developing organic/polymeric electrooptical material systems suitable for fabricating thin films or fibers for photonic applications.

DESCRIPTION: Research proposals are sought for developing organic/polymeric based material systems suitable for photonic applications, and conducting research on prototype devices that can provide insight into properties and processing issues of this class of materials. The materials must have adequate electrooptical coefficient for device research. In addition to possessing the sufficiently high electrooptical coefficient, the material system should be optimized for all the necessary secondary properties suitable for device fabrication and utilization. These properties may include thermal stability, temporal stability, solubility, melting characteristics, low optical loss and compatibility with other materials needed in devices. Device studies that will test the potential of organic/polymeric materials based devices in reaching into performance regimes beyond state-of-the-art or achieving improved affordability will also be considered.

PHASE I : Results should establish the feasibility of the chemistry and the properties of the proposed material system.

PHASE II: Effort should be developing the material to a degree of maturity suitable for utilization in device research.

POTENTIAL COMMERCIAL MARKET: This technology can be applicable to communication networks such as cable TV networks, computer local area networks, high speed and high data rate data transmission in wire and wireless telecommunications, optical data processing and computing.

REFERENCES:

P.N. Prasad and D. J. Williams, "Nonlinear Optical Effects in Molecules & Polymers", John Wiley & Sons, New York, 1991.

AF 97T004 TITLE: SITUATION AWARENESS BASED ON FUSION OF DATA FROM MULTIPLE SOURCES

Category: Basic Research

OBJECTIVE: Develop a semi-automated reasoning system to automatically manage information flow and data fusion, resulting in dramatic improvement in decision aids to the warfighter.

DESCRIPTION: Situation awareness involves the understanding and ability to analyze and act on incoming data from multiple sources. The requirement in the military for automated situation awareness is escalating since the demands for information on the battlefield outpace the ability to analyze that information. More and more sensors are providing better information in many forms at finer levels of granularity, taxing human ability to comprehend and analyze battlefield conditions. Human analysts need help in managing the flow and diversity of information to construct an accurate picture of the battlefield.

PHASE I: Investigate approaches to integrating information in a variety of forms, including data, graphics, video, and natural language and other types of semiotics to construct a coherent and useful description of the environment of interest.

PHASE II: Construct a prototype system using the findings of Phase I that can be used in concert with other decision aids to provide real-time response to rapidly changing environmental conditions.

POTENTIAL COMMERCIAL MARKET: Accurate and timely data fusion will result in more informed decisions by battlefield commanders. These capabilities have potential impact in the financial world (market forecasting and investment decisions) and in disaster preparedness (handling emergencies during natural or man-made catastrophes).

REFERENCES:

New World Vistas--Air and Space Power for the 21st Century (Summary Volume)

AF 97T005 TITLE: MICRO MECHANICAL INERTIAL PLATFORM SYSTEM

CATEGORY: Basic Research

OBJECTIVE: Demonstrate that micro machining can build a very small inertial platform capable of performing the functions of optical referencing and navigation.

DESCRIPTION: This project will design and demonstrate the feasibility of a 3 axis micro miniature inertial platform system that can be used with a telescope or an airplane mounted tracking system, or used in a land vehicle as a navigator reference. Such an instrument will be very useful to a program such as the Airborne Laser that requires an inertial reference for optical pointing. The system is desired to be small enough that it could be mounted on the secondary mirror of a beam expanding telescope, while the goal is to keep the instrument package within a cube 2 inches on a side. The overall intent of this effort is to demonstrate that micro machining components of gyroscopes and accelerometers is feasible for a strapdown inertial platform. A stabilized platform is also acceptable, however. An optical surface, such as a micro mirror will be driven by the system to provide an inertially stable optical reference. Only the platform will be designed and built under this contract, navigation software will be added by the contractor as he deems necessary.

PHASE I: This phase shall be used to conceptually design the basic micro system and demonstrate to the Air Force that such a miniature system is feasible within the state of the art. Although most components have been conceptualized for a system like this, no detailed analysis has been previously done to elucidate achievable system performance levels. This phase will conceptually demonstrate the feasibility of producing the small package and show how this package can be used with a telescope to significantly improve the pointing accuracy. The system will be conceptually designed to operate and measure angular inputs while the telescope is slewing at 1 rad/sec and 2 rad/sec/sec acceleration. The angular performance in this conceptual design system should be less than 10 microradians when subjected to the vibration spectrum of a C-135 at 40,000 ft altitude and 0.8 mach number, and less than 2 microradians under quiet laboratory operation

PHASE II: The phase II objective will be to demonstrate the feasibility of the inertial reference system designed in phase I, through the building and testing of a working prototype. The platform shall be demonstrated as a complete breadboard system. It is expected that this phase will demonstrate achievable system performance and include detailed characterization of the control loop performance. If desired the Air Force will work with the contractor to obtain use of the inertial test equipment at Holloman AFB.

COMMERCIAL POTENTIAL: It is expected that a competitively coated ultra small system as conceptualized here would have several commercial and military customers. The military applications will be on all sorts of pointing telescopes for imaging and for optical communication systems. The commercial use of the system would include

navigation systems for land vehicles and possibly aircraft. If the price can be made low enough for the automobile industry, the produce would obviously have a huge market. It is expected that the contractor will design a system with many options during Phase I, so that as large as possible commercial market will be available.

REFERENCES:

1. Wise, K.D. "Micromechanical Sensors Actuators and Systems." Micromechanical Sensors, Actuators, and Systems, American Society of Mechanical Engineers, Dynamic Systems and Control Division, SDC V.32, ASME, 1991.
2. Gabriel, Kaighan J., Microelectromechanical Systems Program, Advanced Research Projects Agency, January 1995.
3. Gyroscope Theory, Design, and Instrumentation, Wright, Hollister, and Denhard, The MIT Press, Cambridge MA 1969.
4. MEMS: A Closer Look, A2part article, Sensors, the Journal of Applied Sensing Technology, July 1996.

AF 97T006 TITLE: DEVELOPMENT OF HIGH TEMPERATURE SOLID LUBRICANT COATINGS

Category: Basic Research

OBJECTIVE: Develop solid lubricant coatings that can provide lubrication from subambient to 850°C.

DESCRIPTION: The Air Force uses solid lubricant materials in a number of different propulsion applications. For example, solid lubricants reduce friction and wear in rolling and sliding contacts and to protect against fretting and galling. To increase the thrust-to-weight ratio in gas turbine engines (GTE), higher operating temperatures must be achieved. Currently, some solid lubricants are available which provide effective lubrication from subambient to about 400°C while others can operate effectively only above 500-600°C. To meet the increased temperature requirements in GTE's, lubricants that are effective from subambient to 850°C are required. Several approaches have good potential. Adaptive lubricants which undergo chemical changes as temperature increases to continuously provide low friction have high potential[1]. Oxides can be stable at high temperature in the atmosphere, but typically are brittle and can produce abrasive wear debris. Nanocrystalline oxides can deform plastically and provide lubricious surfaces as compared to traditional oxides [2]. Adaptive lubricants reactions are typically irreversible. Thermal cycling may be limited by complete reaction of adaptive components to high temperature lubricant which would be unable to perform at low temperatures. Multilayering and composite structures have been proposed as solutions to this problem. Nanocrystalline oxide coatings can undergo crystal nucleation and growth at elevated temperature. Therefore, the development of lubricious nanocrystalline oxides must consider crystal growth phenomena. Both approaches hold promise, but the issues discussed must be addressed for successful development of a broad temperature range lubricant.

PHASE I: In designing the project, Phase 1 would concentrate on the type of solid lubricant, remembering the issues raised above and the lubricants chemistry.

PHASE II: The logical follow-on would be to concentrate on development, characterization and test of the solid lubricant, with a deliverable of the lubricant as the goal.

POTENTIAL COMMERCIAL MARKET: Besides aerospace applications in both military and civilian, successful development could result in improved high temperature solid lubricants for high temperature/high efficiency automotive engines and other high temperature industrial applications (wire drawing, furnaces, metal working, etc.)

REFERENCES:

1. J.S. Zabinski, M.S. Donley, V.J. Dyhouse, and N.T. McDevitt, Thin Solid Films, 214 (1992) 156-163; M.S. Donley, J.S. Zabinski in, "Pulsed Laser Deposition of Thin Films", edited by D.B. Chrisey and G. K. Hubler, John Wiley and Sons, New York, 1994, 431-453.
2. R. Birringer, H. Gleiter, H-P Klein, and P. Marquardt, Phys. Lett., 102A (1984) 365; J. Karch, R. Birringer, and H. Gleiter, Nature, 330 (1987) 556.

AF 97T007 TITLE: Air Vehicle Technology

Category:

DESCRIPTION: The Flight Dynamics Directorate (WL/FI) is soliciting ideas in six areas. They are: Aging Aircraft, Human Systems Interface, Technology Assessment, Air Vehicles, Fire Suppression and Modeling and Simulation.

AGING AIRCRAFT: A variety of critical service problems are currently plaguing our aging aircraft fleets and threatening them with grounding or shortened service lives because accurate methodologies for prediction and assessment do not exist today. These problems include but are not limited to corrosion fatigue, widespread fatigue damage (WFD), fretting fatigue, fretting corrosion, joint debonding, composite delamination, and composite impact damage. Research efforts should involve generating analytical methodologies, validating these methodologies through experimental testing, and integrating these methodologies with existing aging aircraft computer codes.

PHASE I: Develop computer code modules suitable for integration with existing deterministic, probabilistic, and/or repair analysis computer programs as well as advanced life extension techniques.

PHASE II: Methodologies and techniques developed in Phase I will be validated by experimentation.

HUMAN SYSTEMS INTERFACE: It is of utmost importance to initiate a project that develops and demonstrates decision aids, information controls, and display formats that foster data fusion; and situation awareness, assessment, and response for operators of multiple Uninhabited Combat Aerial Vehicles (UCAV). The expectation is that the resulting operator-vehicle interface will reduce workload and enable mission effectiveness for a single operator controlling up to four UCAVs performing a lethal Suppression of Enemy Air Defenses (SEAD) mission. The operator is not expected to perform rudder and stick flying but to give tactical and strategic direction as a human in the loop. The objectives of this program are to improve UCAV operator productivity and to enhance mission effectiveness. The main goal is to exploit decision aid and 3D display technology to support a single operator of multiple UCAVs performing a SEAD mission in conjunction with other flights of uninhabited and inhabited aircraft.

PHASE I: A multi-part analysis needs to be performed and reported. (1) Concept of operations to explore the application UCAVs in a SEAD mission. (2) Operator-vehicle interface requirements analysis, to include an analysis of current and future data sources that could be used as inputs. Applicable technologies such as decision-aiding, communications, information controls, and display formats should be a part of the analysis, as well as the skills and capabilities required of the operator. (3) Design and illustrate a capability based on the concept of operations and the requirements analysis. The design should integrate the data sources and applicable technologies into an operator station that would permit a single operator to control four UCAVs performing a SEAD mission. (4) Produce a report that, via illustration and discussion, lays the foundation for the development and application of specific technologies.

PHASE II: Select a meaningful decision aid and display format target. Produce a design definition sufficient to generate software code. The design should include an interface control document. Implement a prototype capability based on the design reported in Phase I and integrate the prototype with a pre-existing operator evaluation system. Demonstrate that the operator evaluation system, coupled with the new capability, delivers statistically significant improvements in operator performance.

TECHNOLOGY ASSESSMENT: There is a need to develop a standardized technology assessment capability for government, industry, and academia to use for design analysis of new and upgraded aircraft. Current methodologies do not address merging technologies and their synergistic contributions to the goals and payoffs of a new aircraft design or upgrades to existing aircraft. An analysis program that is user friendly and features commonality, and reasonable size is required. These needs can be met because advances in computing size, speed, and connectivity make powerful tools available and military-industrial partners recognize that cooperation and leveraging are the only way to overcome the challenges of limited resources. The program should provide a common language, take maximum advantage of currently developed software, and state-of-the-art computer hardware, improve the interface to more sophisticated analysis such as mission effectiveness, maintainability and reliability and survivability, to clearly quantify the benefits of inserted technologies.

PHASE I: Define the total program including cost, assessment methodology, architecture, and developmental requirements.

PHASE II: Development and validation of analysis program.

AIR VEHICLES: Substantial gains in military air vehicle performance are realized through accurate aerodynamic simulation. Exploratory wind tunnel research, often yielding only integrated forces and moments, is inadequate to thoroughly understand and optimize aerodynamic design. This is particularly true of highly maneuverable air vehicles which possess significantly expanded flight envelopes. Pressure sensitive paint (PSP) techniques can provide low cost, non-intrusive, full-field pressure measurements, very early in the design cycle, to extensively enhance the understanding of the aerodynamics underlying the force and moment data. However, this

technique is not currently applicable at low subsonic speeds where much of the flight envelop of these highly maneuverable air vehicles exists.

PHASE I: Will investigate the underlying photochemical, material science, and image analysis issues related to full-field simultaneous PSP measurements in very low speed flows. This is expected to include research on, but not necessarily limited to, the following: multi-lumiphore coatings that allow simultaneous pressure, temperature and reference images; eliminating the need for temperature corrections and complicated image registration schemes; paint chemistry to quantify the effect of the paint binder matrix on system dynamic characteristics and research on lumiphore coatings to decouple pressure, temperature and illumination effects. The Phase I will also examine the specific issues related to implementing such a system both in the VWT for captive spin testing and in the SARL.

PHASE II: Will engineer the required coatings, design and develop the measurement system (illumination sources, imagers, and data acquisition system), and develop the image analysis techniques for a PSP system for making high quality measurements in the SARL, VWT, or other facility, as suitable.

FIRE SUPPRESSION: The search for an alternative to halon as fire suppressants as a result of the Montreal Protocol ban on ozone depleting substances has yielded few optimum replacements for current deployed systems. Newly-found chemically acting agents still pose unresolved toxicity questions. An innovative approach to suppression of fires is to affect chemical kinetics of critical combustion reactions by exciting critical radicals by exposure to selective photochemical excitation and other innovative approaches such as the use of electric or magnetic fields. The excitation and de-excitation of critical free radicals by means of the use of directed energy can interfere with critical chemical kinetic reactions and cause changes in the speed of flame propagation and produce the eventual extinction of a fire.

PHASE I: Should encompass a preliminary experimental study to address the relative effectiveness of using particular (OH, H, CHO, and CH₂O to begin with) wavelength radiation to suppress stoichiometric flames. A literature search on radiation effects on flame speed propagation will also be required. An estimate on power requirements in a per unit flame irradiance basis will also be required and used as a basis for a Phase II program. Proposed cost of the Phase I effort: \$100,000. The Air Force will make available use of equipment to assist in experimental studies.

PHASE II: Should consist of thorough systems design of a radiation-based fire suppression system which will encompass power and control electronics, the design of an ergonomically suitable delivery system, and construction of a small scale prototype. theoretical analysis of suppression capability and yields will also be required. An economic analysis of large scale development will be required for commercial development. Proposed cost of the Phase II effort: \$700,000.

MODELING AND SIMULATION: It is necessary to identify a design environment and develop a design process which establishes and automates a bi-directional flow of design information between conceptual data and detailed data. Military flight systems development traditionally follows a regimented path starting with conceptual design, leading to preliminary design, followed up by detailed design, manufacturing and production. Many of the decisions about the systems are fixed at the conceptual level, when the least information is available. The far-reaching goal of this topic is to provide the conceptual designer with high fidelity computer generated design data and ultimately give the United States Air Force the ability to make meaningful design tradeoffs between cost and performance. New design architectures are emerging which have the potential to automate the connections between mission planning and Manufacturing applications. These new design architectures or environments can be programmed to facilitate a comprehensive aerospace design process from design layout to manufacturing. In addition, they have the potential to automate design feed forward and feed back in a recursive design process. The architecture should not pre-suppose the design process by assuming that geometry, CSM, CFD, etc., drives the airplane design. The architecture should use a high-level modeling language which works with inter-related objects. The architecture must also be able to save and archive design and engineering data for large complex systems. Ideally, the architecture would be portable to a wide variety of computer platforms including DEC, SGI, HP and IBM Unix workstations and a networked heterogeneous system of computers.

PHASE I: Will focus on a demonstration of the feasibility of design feed forward and design feedback between conceptual level data and preliminary design data. The first step will identify a commercially available design architecture capable of automating bi-directional connections between design data and manufacturing data for flight systems. The second step is to identify a simplified (idealized) design process involving airframe components at the conceptual level and linear aerodynamic and structural analysis at the preliminary level. A limited suite of modules for geometry modeling, engineering analysis and design optimization will be selected and modification requirements identified. The feasibility of enabling a complete concurrent design process will be demonstrated after developing a simple feed forward and feed back process between design layout and preliminary analysis of an airplane wing.

PHASE II: Will extend the activity of Phase I to include a demonstration feed forward and design feedback between conceptual level data and detailed design data including manufacturing. This extended demonstration will focus on the manufacturing of one or two component such as the wing spar or the wing skin.

POTENTIAL COMMERCIAL MARKET: Commercial applications in the above areas exist in the aerospace and other industries for fire fighting, air traffic control, search and rescue, weather monitoring and health care.

Additional technical information is available. Please fax or e-mail your request for additional information to Ms. Madie Tillman specifying the subtopic(s) of interest. Requested information will be mailed to you. Fax: 513-255-6788/3438. E-mail: tillmaml@b045mail.wpafb.af.mil.

AF 97T008 TITLE: Affordable Tooling for Composite Structures

Category:

OBJECTIVE: Develop composite processing tools and tooling approaches that offer lower cost and shorter fabrication lead times with adequate durability and thermal performance characteristics.

DESCRIPTION: Organic matrix composites structural technology impacts virtually every current and new weapon system. These structures provide critical performance enhancements which enable the DoD to field superior weapons systems. Although organic matrix composites are used in a wide spectrum of vehicle structures, the high cost of these structures may severely limit the implementation of this critical technology to its fullest potential. Therefore, new technologies which allow for the affordable implementation of composite structures must be pursued.

Tooling costs have been identified as a high cost area especially in the prototype environment and as production rates continue to drop. Composite cure tools must produce dimensionally accurate parts, (match the coefficient of thermal expansion (CTE) of the composite part), be affordable to demonstrate the tooling approach in a prototype environment, and be durable enough to meet the requirements of production use. INVAR tools have been shown to meet thermal and durability requirements and are being used extensively on ongoing aircraft production programs. However, INVAR tooling is very expensive and requires significant fabrication lead times.

New technologies and methodologies are needed to develop composite processing tools that are low cost, highly durable, have compatible thermal performance characteristics, and short fabrication lead times. The new tooling technology and methodology should address the cost of fabricating both the tool face and substructure. It must provide all the capabilities of internal tooling points, scribe lines, and vacuum ports as available on current INVAR cure tools.

PHASE I: Develop and evaluate tooling system concepts and designs that provide high performance composite cure tools. Phase I should provide a description of the tooling approach, preliminary designs of the tooling system, thermal analysis of predicted thermal performance, and cost analysis of anticipated tooling fabrication costs.

PHASE II: Develop and demonstrate the new composite processing tool system on a significantly complex tool. Verify the Phase I thermal and cost analysis predictions and demonstrate the tooling performance.

POTENTIAL COMMERCIAL MARKET: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical.

REFERENCE:

Contract No. F33615-89-C-5715, "Advanced Tooling Manufacture for Composite Structures (ATMCS)", WL-TR-94-8027 - December, 1995. Northrop Grumman Corporation.

AF 97T009 TITLE: Characterization of Particle Damping for Gas Turbine Engine Blades

Category:

OBJECTIVE: Characterize the interaction of metallic or non-metallic particles in rotating turbine engine components (particles under compaction) and to predict the level of damping to aid in the design and optimization of particle damping treatments.

DESCRIPTION: The push for improved performance and lighter weight in turbine engines has led to highly stressed components susceptible to high cycle fatigue (HCF) failures. A method to control these failures is to incorporate passive damping into the design of turbine engine rotating components. Due to the extreme temperatures and high centrifugal loads, application of damping treatments to turbine blades is extremely limited. A potential solution to this problem is the application of particle damping, which can be considered a variant of the class of impact dampers. For the blade configuration, minute quantities of either metallic or non-metallic particles are encased within a small cavity and energy is dissipated by the interaction of these particles within the walls of the cavity through friction and/or momentum exchange. It has been shown empirically that this configuration can develop significant damping; however, research is necessary to characterize the phenomena in a rotating field (particles under compaction) and research is also needed in the design and optimization of particle damping to improve the ability to predict damping effectiveness.

PHASE I: Specific experiments should be conducted to verify the critical aspects of the defined concept and a design system established to predict the results thereof.

PHASE II: Fabricate a prototype demonstration of the damping concept of Phase I and spin test the prototype to demonstrate the predicted damping effectiveness and durability.

POTENTIAL COMMERCIAL MARKET: This technology will provide the required vibration suppression needed in turbine engine rotating components to reduce HCF failures. The benefits of reducing HCF is increased affordability, engine performance, and aircraft availability, all of which are critical to the Air Force and to the commercial engine market.

REFERENCE:

Panossian, H., Structural Damping Enhancement via NOPD Technique, Journal of Vibration and Acoustics, pp. 101-105, Vol. 114, January 1992

ARMY

Submission of Proposals

The responsibility for the implementation, administration, and management of the U.S. Army STTR Program rests with the Army STTR Program Management Office at the U.S. Army Research Office (ARO). You are invited to submit STTR proposals to ARO at the address below. Proposals must be received at this address no later than the solicitation closing date and hour indicated in the solicitation.

U.S. Army Research Office
ATTN: STTR-97 (LTC Jones)
P.O. Box 12211
4300 South Miami Blvd
Research Triangle Park, NC 27709-2211

The Army has identified twelve technical topics, numbered ARMY 97T001 through ARMY 97T012, to which small businesses and their partner research institutions may respond. Only proposals addressing these topics will be accepted for consideration for the Phase I STTR Program.

The Army anticipates sufficient funding to allow award of one to three STTR Phase I contracts to firms submitting the best proposals in each topic area. Awards will be made on the basis of technical evaluations within the bounds of the funds available to the Army at the time of award. If no proposals in a topic merit award relative to the proposals received in other topics, then the Army will not award any contracts for that topic.

Proposals for Phase I are limited to a maximum of \$100,000 over a period of six months.

Any Phase II contracts resulting from Phase I proposals submitted for this solicitation will be limited to a maximum of \$500,000 over a period of two years. Phase II contracts will be structured as a single year contract with a one year option.

NOTE: Offerors for ARMY TOPICS A97T001 through A97T009, A97T011, and A97T012 are encouraged, but not required, to request and complete administrative contract data forms available upon from the STTR Program Management Office at the above address. The data requested on these sheets are required in the event that a proposal is selected for contract award. Completing these data sheets in advance will shorten the processing time from selection for contract award to contract award for those proposals selected for award. Offeror election to request or not request administrative contract data forms does not impact the evaluation of any proposal in any way.

ARMY 97T001 TITLE: Biomolecular/Biomimetic Sensor System for Trace Chemical Explosives Detection

DESCRIPTION: The problem of detection and neutralization of land mines is of very great concern to the Army not only for reasons of individual soldier and troop safety, but also for reasons of cost for existing operations and near-term countermeasure measures in the field. The promise of contributions of biologically inspired sensor strategies toward solution of this problem is substantial, but fulfillment of that promise requires that proposed biomolecular or biomimetic

explosives detection schemes capture the concepts, and in some cases, perhaps even the materials and signal processing characteristics, which have been functionally optimized in nature for purposes of chemical detection for a variety of reasons. Explosives-sniffing dogs are still the vapor detector of necessity in many mine-detection situations, and remain in standard use for detection of explosives in terrorist threat sweeps. Unique and powerful insight into innovative approaches toward fabrication of next-generation mine and explosives detection systems is now available through very recent successes in understanding the nature and applicability of a number of advances in biosciences research. These include, but are not limited to: (1) olfactory receptor mechanisms, (2) combinatorially directed mutagenesis and forced evolution of biomolecular function and, (3) novel neuronal processing paradigms for representation of sensory information.

PHASE I: Identify, and partially characterize, best candidate system for providing research focus on potential for development of biologically-derived sensors capable of high-sensitivity, high-selectivity detection of explosives.

PHASE II: Provide realistic approach toward design and implementation of an explosives trace chemical detection system with a capacity to emulate the naturally occurring sense of olfaction, particularly with regard to its evolution of molecular diversity for binding site reaction and signal generation, and to its extraordinarily effective pattern recognition capabilities.

REFERENCES:

1. Molecular Recognition and Olfactory Processing in the Mammalian Olfactory System. K. Mori and Y. Yoshihara in Progress in Neurobiology, Vol. 45, No. 6, pages 585-619; April 1995.
2. Exploring Molecular Diversity with Combinatorial Shape Libraries. D. J. Kenan, D. E. Tsai, and J. D. Keene in Trends in Biochemical Sciences, Vol. 19, No. 2, pages 57-64; February 1994.
3. Pattern Recognition Computation Using Action Potential Timing for Stimulus Representation. J. J. Hopfield in Nature, Vol 376, pages 33-36; 6 July 1995 (See also News and Views p. 21-22).

ARMY 97T002 TITLE: Induced Gratings for Optical Limiting

DESCRIPTION: Optical limiting devices for the visible region (400-650nm) are being sought which rely on the use of self-induced gratings within nonlinear materials. This approach must be passive, broadband over the visible spectrum with a transmission greater than 10%, and, while a laser source is present, reduce the transmission by more than 100X. Devices sought would ideally respond on the 1 nanosecond time frame to Q-switched laser pulses, and 100 microseconds or less is acceptable for quasi-cw sources. Response threshold and response time must be adequate to insure that the device will limit incoming laser radiation to an acceptable level (below 50% probability of eye damage). Potential approaches might utilize novel optical designs and grating formation in nonlinear optical materials such as photorefractive materials, liquid crystals, X[3] materials, or others as appropriate.

PHASE I: Demonstrate proof-of-principle.

PHASE II: Implement a prototype sufficient to identify and resolve any key problems that could otherwise prevent successful commercialization.

REFERENCE:

1. L. Tutt and T. Boggess, "A Review of Optical Limiting Mechanisms and Devices Using Organics, Fullerenes, Semiconductors, and other Materials," Prog. Quant. Electr., Vol. 17, pp. 299-338 (1993).

POTENTIAL COMMERCIAL MARKET: Commercial applications could include high-speed communications or wireless devices such as interconnects.

ARMY 97T003 TITLE: High Temperature Tribology for Advanced Propulsion Systems

DESCRIPTION: Future high performance propulsion systems for Army tactical air and ground vehicles will be designed to provide very high power densities (horsepower/volume). These will be achieved through operation at near-stoichiometric combustion conditions, at very high rpm, and through reductions in parasitic losses, including friction. All of these approaches are severely constrained by the current state-of-the-art in high temperature tribology (friction, wear, and lubrication). New approaches to the problems of high temperature tribology are needed to provide lubrication at temperatures above 300 °C and innovative approaches are needed for providing low coefficient of friction (less than 0.1) under extreme conditions of temperature and pressure. Opportune areas for exploitation include, among others, vapor phase and solid lubrication concepts, diamond and diamond-like coatings, and new fluorination technology to

produce surfaces with very low friction yet with high tolerance to high temperature oxidizing atmospheres.

PHASE I: Screening of candidate approaches, selection of approach to be used in Phase II, based on laboratory tests and analysis.

PHASE II: Demonstration of capabilities of the selected approach over the range of temperatures, loadings and relative velocities representative of engine operating cycles.

ARMY 297T004 TITLE: Chemical Process Models for Oxidative Destruction of Toxic Organic Materials

DESCRIPTION: Chemical Engineering Process Models are sought for design and simulation of reactors to destroy toxic organic materials by supercritical water oxidation. Toxic organic materials of greatest interest are those containing the heteroatoms: phosphorus, sulfur, and halogens. Using best available data as inputs, the models will give optimum operating conditions for effective destruction, destruction efficiency as a function of throughput, reactor configuration,

product species and concentrations, capital and operating costs, and energy needs. The models will provide information about potential onset of reactor upsets and enable diagnosis of failures. Models must include the following modules: hydrodynamics, salt deposition, chemical kinetics, and supercritical solution properties.

PHASE I: Develop model including all required modules as proof-of-concept.

PHASE II: Develop simulator and test against appropriate data set from pilot plant tests (in literature or new measurements as required). Package simulator to be "user-friendly" for potential DoD and civilian customers.

ARMY 97T005 TITLE: Production of Raw Materials in Plants

DESCRIPTION: Plant bioengineering has been developed to the point where plants can now be used as miniature factories to produce raw materials such as polyester-like compounds for clothing, soaps and oils, biodegradable plastics, as well as biologically active molecules such as antibodies and vaccines. Military and civilian applications of these raw materials include: protective coatings for equipment and machinery; clothing with superior protective and wear

properties; biodegradable single and multiple-use disposables; biodegradable machine oils and lubricants; edible and/or cost-effective immunizations and therapeutics; biological materials with tailored properties. This technology will reduce reliance on oil-derived raw materials and will create environmentally-benign alternatives to current industrial processes for products such as synthetic fibers (such as natural cotton-polyester blends), edible and non-edible oils, drugs and

pharmaceutical compounds, and environmentally-friendly soaps and detergents. Research efforts are needed in plant biotechnology to improve on current techniques for plant transformation, to engineer bacterial, viral, or fungal enzymes for use in plants, and to discern biochemical pathways involved in the production of useful raw materials or proteins.

PHASE I: Identification and characterization of useful genes or biochemical pathways in plants or other organisms that can be used in the production of raw materials; engineering and/or transforming suitable plant species with the ability to produce these raw materials.

PHASE II: Development and optimization of cost-effective transgenic or engineered plant lines that produce raw materials. Field trials to test the growth characteristics of the plant lines and the feasibility of isolating the desired materials from the harvest.

ARMY 97T006 TITLE: Non-Biological Technologies for Multi-Sensor Detection of Unexploded Mines

DESCRIPTION: Many present-day approaches to detect unexploded mines attempt to exploit a single physical property associated with the mines, i.e., a difference in either the optical or electric properties, or the presence of a small quantity of metal. However, a crucial problem is the elimination of clutter particularly in situations of humanitarian demining. A non-biological multi-sensor approach to unexploded mines has the advantage that complimentary characteristics of mine detection can be combined to minimize clutter. With current methods there has been less focus on technologies that seek to detect the explosive material directly or can detect the low atomic number components of "plastic" mines. This is because atom-specific detection of very low vapor-pressure explosive compounds is difficult because biological, smell-detection methods cannot be used and also because most physical contrast methods work best for high atomic number materials such as metals. Laboratory analytical techniques currently permit highly sensitive, chemical and/or physical analysis, but these systems are large, are not real-time, and require detailed knowledge on the part of the system operator. The Federal Aviation Administration has sponsored work in explosives detection, but systems resulting from these efforts are typically geared toward large, fixed operations and do not have the selectivity which can be achieved with a multi-sensor approach. Recent advances in sensors such as surface acoustic wave technology, nuclear quadrupole resonance (NQR), collimated X-ray backscatter techniques, conducting polymer-based techniques, photoacoustic cells, and mass spectrometry, among several others, may afford new opportunities for the detection of explosives in portable military applications. This topic addresses novel techniques with the potential for applications in a multi-sensor system for detection of explosives or other mine components.

PHASE I: Demonstrate detection of explosives (vapor or condensed phase) other mine components under laboratory conditions at field-level concentrations in the presence of common environmental interferant.

PHASE II: Using a prototype multi-sensor system, demonstrate detection of explosives under field-conditions and evaluate the probability of detection and false alarm rate.

REFERENCES:

1. J. G. Campbell and A. M. Jacobs, Nuclear Science and Engineering 110, 417 (1992).
2. Marc Nyden, in A Technical Assessment of Portable Explosives Vapor Detection Devices, NIJ Report, 300-89 (1990).

ARMY 97T007 TITLE: Novel Haptic Interface

DESCRIPTION: The recent evolution of virtual environments and intelligent systems requires natural interaction between machines and users. Compared to presentation of visual and auditory information, methods for tactile information have not been sufficiently developed. Haptic display as an augmentation to visual display can improve perception and understanding both of force fields and of world models populated in the synthetic environments. It allows users to reach into virtual environments with their hands, so they can touch, feel, grasp, and manipulate simulated

objects. Techniques are sought to develop and integrate novel force feedback device design, interactive 3-D graphics and visualization, real-time kinematics, geometric modeling and physically-based simulation, in order to determine contact forces and provide real-time interaction for manipulating virtual objects. Application domains span from scientific visualization, education, training, entertainment, design prototyping, and medicine, to remote high-risk operations.

PHASE I: Develop a detailed design for an integrated system as identified above. Sound algorithmic designs and robust, efficient computational tools are essential for modeling of both rigid-body and deformation dynamics. Novel geometric techniques coupled with physically-based modeling applied to innovative force feedback devices offer new avenues toward promising advancement in this area.

PHASE II: Implement the detailed design developed in Phase I and produce a working proof-of-concept system. Demonstrate the proof-of-concept system on an appropriate application domain which has the potential for dual-use or commercial exploitation.

POTENTIAL COMMERCIAL MARKET: Friendly and natural haptic interface is not only crucial for the Army's missions in vehicle and rotorcraft maintenance training, but is also important to many civilian applications including

rapid prototyping, haptic rendering of molecular structures, tolerance verification for virtual mock-ups, surgical simulation, and teleoperation. This system could be a valuable tool for manufacturing, medical diagnosis, scientific exploration, as well as personnel training and education.

ARMY 97T008 TITLE: CAD Tools for Mobile, Wireless, Multimedia Communications Networks

DESCRIPTION: Wireless networks are emerging as one of the fastest growing areas of communications. However, the design and operation of next generation mobile, wireless multimedia (voice, data, and video) communications networks is incredibly complex. In the tactical environment in particular, the huge size of the network cannot be expected to be

effectively managed without the use of intelligent, computer aided design (CAD) and simulation tools. User mobility and the types of services planned increase the complexity further. User friendly and tractable (intelligent) CAD tools are needed to assist system designers and operators in the simulation (emulation) of these systems. The intelligence associated with the CAD tool is expected to be found in, but not limited to, the use of efficient simulation methods to reduce the simulation run time, or in the design of the user interface to make manipulation of critical system parameters simpler as well as the presentation of the results more easily understood. The overarching objective is to develop an intelligent CAD tool for the design, analysis and operation of mobile, wireless, multimedia communications networks.

PHASE I: Develop a proof-of-concept of an intelligent CAD tool by integrating CAD techniques with network simulation and control methods.

PHASE II: Develop a prototype sufficient to identify and resolve any key problems that might otherwise impede successful commercialization.

POTENTIAL COMMERCIAL MARKET: Existing commercial CAD tools are available for the design and operation of conventional fixed networks, but no CAD tools exist for the emerging mobile, wireless multimedia communications network market.

ARMY 97T009 TITLE: Modeling and Analysis of Energy Absorption in Advanced Composites

DESCRIPTION: Since laminated composite materials are subject to various types of dynamic loads during their service life, it is important to investigate the basic mathematical modeling and computational structural mechanics issues associated with deformation due to these loads. These materials are often subjected to impact loads causing large non-linear deformations, so it is vital to address the associated modeling issue to account for them. Moreover, the exact load distribution and its variation in time are frequently unknown. The numerical analysis of such problems and the

prediction of the service life of the structures might be facilitated through the application of probabilistic methods in structural dynamics. Numerical difficulties often make it almost impossible to calculate the normal modes of multi-span beams, for example, because of the close proximity of the natural frequencies in each frequency band. Although the use of advanced, laminated composite materials is becoming more prominent in rotary and fixed wing aircraft applications, very limited knowledge regarding their failure mechanisms is available. In particular, the phenomenon of progressive failure in laminated composites is still not well understood. Imperfections, such as delaminations, fiber waviness, or matrix cracks, can significantly reduce the load carrying capacity of a composite structure. These often occur in the material production process and during operational life due to impact damage at low and high velocity. The presence of delaminations may allow laminate failure initiated by delamination buckling, which will greatly reduce the load carrying capacity, leading ultimately to structural failure. The phenomena of delamination and matrix cracking can affect the life of the structure. An important application of composites in rotary wing aircraft is in crashworthy components, such as landing gears and the helicopter sub-floor.

PHASE I: The goal is the development of a validated progressive failure methodology that may incorporate probabilistic and/or statistical techniques. The failure theory should be capable of modeling effects due to the presence of imperfections, damage development including transverse matrix cracking, and delaminations under combined loading conditions at quasi-static and dynamic loading rates. The methodology should predict the stiffness reduction of the composite structure based on the prescribed damage to the material. The analysis should provide an estimate of life prediction given the known damage state of the composite structure for prescribed future loading conditions. Existing data in the literature should be used to validate the analysis approach, demonstrate that it correctly predicts the load-displacement response of a structural element for discrete values of the input parameters, and reveal deficiencies for certain types of loading conditions or particular laminate stacking sequences. The modeling issues must include ply level

considerations, material and geometric non-linearities, structural imperfections such as delaminations and matrix cracks. The static and dynamic response of such composites must be investigated under complex loading conditions typical in rotary wing applications. Probabilistic methods (including probabilistic finite element schemes) for the numerical prediction of structural failure modes are especially important in cases in which the precise nature of an impact load is not known. For example, a combined probabilistic and convex-theoretic approach toward uncertainty in statistical loading parameters might be used to estimate the least favorable stochastic responses of some types of structures. Research tasks might include: (a) delamination buckling, post-buckling, and growth studies (including multiple

delaminations), (b) modeling other imperfections such as matrix cracks, (c) dynamics of delaminated composite structures, (d) dynamics of impact loading (response analysis and comprehensive modeling of progressive failure mechanisms), or (e) mechanisms of energy absorption in composites.

PHASE II: The analytical and numerical methods developed in Phase I must be integrated in the form of numerical analysis tools and computer software with a three-dimensional graphics capability focused on post-processing operations that would facilitate the display and interpretation of the failure modes. It will be particularly useful to develop this software in a modular fashion (e.g., a module for dynamic buckling analysis), so that it can be integrated into general purpose industry oriented structural analysis codes such as DYNA3D, ANSYS, PATRAN, or MSC NASTRAN. The software should use a common graphics file transfer protocol, such as IGES, to interact with CAD systems. The developed analysis codes should be suitable for use in conjunction with established optimization techniques to perform design trade-off studies of composites undergoing complex deformations (such as crashworthy design, design to prevent delamination growth processes during delamination buckling, etc).

POTENTIAL COMMERCIAL MARKET: Military and civilian applications include improvements to rotary and fixed wing aircraft design, safety, and manufacturing. Analogous applications are also possible in land vehicles and weapon systems.

ARMY 97T010 TITLE: In-Situ Stabilization of Geologic Materials by Vitrification Using Plasma Arc Technology

DESCRIPTION: Poor rock and soil performance in foundations and slopes impacts negatively on structures and mission activities at Army facilities. The negative impacts include increased costs of repair and maintenance of existing structures and transportation corridors, expensive design accommodations for new construction, and degraded training and mission accomplishment. Electrically-generated plasma arc technology has been shown through R&D programs supported by the USACE, NSF, and FHWA to be effective in fusing soil materials into a vitrified material with enhanced geomechanical properties compared to the problematic soils. The applicability of similar plasma arc technology to rock and soil-rock combinations must be demonstrated and the field-scale feasibility of such plasma arc technology to stabilize real world foundation and slope materials must be determined to assess the benefits to the Army mission. This proposed technological development has great potential for commercialization in the arena of Small Businesses in the form of contracted engineering services.

PHASE I: Complete laboratory-scale experiments to: characterize the plasma arc vitrification process in rock materials; determine the mechanical properties of the fused material; and determine the mechanical inter-relation of the fused mass with the surrounding undisturbed materials.

PHASE II: Accomplish intermediate-scale testing directed toward use of plasma arc equipment under field conditions. Develop field demonstration plans using plasma arc technology in typical foundation and slope engineering situations at military installations. Plan development includes acquiring use of field-scale semi-mobile plasma system. Demonstrate use of field-scale plasma arc technology to reinforce rock or rock/soil foundation and rock slope typical of military installation conditions.

REFERENCES:

1. Circeo, L. J., Jr., and Mayne, P. W. (1993) In-Situ Thermal Stabilization of Soils Using Plasma Arc Technology. Final Report to National Science Foundation, NSF Grant MSS-9113134, Georgia Institute of Technology, Atlanta, GA.
2. Circeo, L. J., Jr., Camacho, S. L., Jacobs, G. K., and Tixier, J. S. (1994) Plasma Remediation of In-Situ Materials - The PRISM Concept. Thirty-third Hanford Symposium on Health and the Environment: In-Situ Remediation, Pasco, WA.

ARMY 97T011 TITLE: Gradient Hardness and Wear-Resistant Materials

DESCRIPTION: Erosion and wear is detrimental to current and future Army materiel as the Army after next faces increasing challenges to reduce weight and vulnerability while increasing materials durability. Improvements in transparent armor, impact resistant windshields, bar coating windows, watch glasses, gun recoil liners, etc will result from the availability of lower cost ultrahard diamond-like carbon materials that provide marked improvements in shock/impact and erosion resistance. Novel processing approaches involving plasma immersion, magnetron sputtering, MeV

current ion and e-beams can provide new synthesis routes for gradient property prototype materials of good mechanical and/or optical quality that have reduced residual and delaminating stresses.

PHASE I: Provide physico-chemical analysis for target materials selection, prototype materials, residual stress and chemistry characterization, and thermal or erosion performance modeling/evaluation. Phase I will involve academic, industrial and government partners, will provide a materials property and characterization profile, and a cost benefit analysis for process scale-up to provide 8x8in flat and 4in radius hemisphere 1 to 2 mm thick and larger parts.

PHASE II: Prototype process scale up to provide 25 8x8in flat and 25 4in. radius hemisphere ultrahard samples with 1 to 2 mm gradient properties and reduced residual and delaminating stresses.

ARMY 97T012 TITLE: Real-Time Supervisors for Reactive Systems

DESCRIPTION: It is impossible to "guarantee" acceptable, or fault-free, performance and to access system health for large complex systems (software and physical systems) under all possible operating or input circumstances. Appropriate modeling, design, and testing methodologies provide varying degrees of confidence in system performance characteristics. Appropriate modeling, design, and testing methodologies provide varying degrees of confidence in system performance characteristics. However, actual performance can be critically affected by unanticipated operational circumstances, design flaws or omissions, subsystem malfunction, or system impairment. For example, for rotorcraft and aircraft, in-flight conditions cannot be adequately recreated on the ground, leading to inadequate testing and certification of a system that might fail under certain flight conditions, ultimately leading to high maintenance cost, loss of mission, equipment and even life. Real-time supervisors for reactive systems (systems that respond continuously to environmental/input stimuli during the course of operations) are conceptual entities designed to enable monitoring of complex system operations for purposes of insuring that operations are within acceptable bounds, or system condition/status is "normal". In principle, these supervisors may also be used to accumulate operational data for a variety of other purposes including machine learning, adaptive control, crisis amelioration, safety management, and system maintenance or refinement. Research is needed in the areas of formal models and methods, fault tolerant systems, machine learning, hybrid systems, smart structures and materials and control design and software design for complex hierarchical systems. The ultimate goal is to develop an efficient monitoring mechanism capable of performing real-time diagnostics/prognostics/supervision.

PHASE I: Research is needed to develop formal models and methods for the creation of approaches to the implementation of real-time supervisors for reactive systems. The proposed models, real-time algorithms, and methodologies should address diagnostics and prognostics for dynamic fault-tolerant systems. These approaches should serve to monitor hundreds of sensors, or status-generating system nodes in a fraction of a second. The proposed concepts, ideas, and approaches should have sound theoretical foundations which allow for thorough evaluation, and where possible feasibility should be demonstrated.

PHASE II: Demonstrate feasibility of approaches by developing real-time algorithms for a proposed test-bed system. In addition to diagnostics/prognostics for the detection and isolation of multiple faults/errors/failures, the proposed approach should extend to dealing with system reconfiguration, fault recovery, and machine learning for systems and safety management. Issues of integration into the system should also be considered, e.g. embedding algorithms into a chip or processor card to insert into system.

POTENTIAL COMMERCIAL MARKET: Commercial rotorcraft, commercial airlines, automotive companies, railroad companies.

BALLISTIC MISSILE DEFENSE ORGANIZATION (BMDO)
SMALL BUSINESS TECHNOLOGY TRANSFER PROGRAM
Submitting Proposals

Send Phase I proposals (**six** copies of the full proposal, PLUS one separate copy of Appendices A and B) by US mail to (Appendix A and B need not be red):

Ballistic Missile Defense Organization
ATTN: TRI/STTR
7100 Defense Pentagon, Room 1E149
Washington, DC 20301-7100

For Administrative Help **ONLY**: Call **800-937-3150**
Electronic Access: **800-WIN-BMDO** (Bulletin Board System) or **www.futron.com/bmdo/sbir.html** (A Home Page/World-Wide Web)

Proposals delivered by means other than US Mail must be delivered to Room 1D110, The Pentagon, Washington, DC. **WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient.** (NOTE: Only a few courier services have access to the Pentagon.) BMDO will acknowledge receipt if the proposal includes a self-addressed stamped envelope and a form (like Reference B) that needs only a signature by BMDO.

BMDO seeks the most innovative technology to find and disable a missile in flight - lighter, faster, smarter, more reliable components. Proposers need not know details of possible BMDO systems.

BMDO seeks to invest seed-capital, to supplement private capital, in a product with a future market potential (preferably private sector) and a measurable BMDO benefit. BMDO will not compete with private or government markets in that it will not further develop concepts **already mature enough to compete** for private capital or for government development funds. BMDO prefers projects which move technology from the non-profit institution into the private sector market through a market-oriented small firm. BMDO expects to fund about 20 projects.

Phase I should be only an examination of the feasibility and competitive merit of the concept with an average cost about \$60,000. Although proposed cost will not affect selection for negotiation, contracting may be delayed if BMDO reduces the cost ceiling. Phase I competition will give approximately equal weight to degree of innovation and market potential. Phase II competition will give more weight to future market potential. BMDO expects keen competition for both Phases.

Because BMDO seeks the best nation-wide experts in innovative technology, proposers may suggest both technical reviewers and contract technical monitors by enclosing a cover letter with the name, organization, address and phone number (if known), and a rationale for each suggestion. Each must be a government employee. BMDO promises only to consider the suggestion.

BMDO 97T001 TITLE: Sensors

DESCRIPTION: Sensors provide warning of attack, target identification, target discrimination from non-target objects, and determination of kill. New and innovative approaches are sought for sensors in the infrared, visible, and ultraviolet wavelengths for passive, active, and interactive sensors. Examples are: cryogenic cooling, superconducting focal plane elements, low power optical beam steering, passive focal plane imaging, interferometry for imaging, optics, diode pumped lasers, and optical materials.

BMDO 97T002 TITLE: Electronics and Photonics

DESCRIPTION: BMDO needs advances in processing capacity made possible by advances in electronics and optoelectronics. BMDO wants to advance integrated circuits, detectors, sensors, large scale integration, and radiation hardness. Advances are sought in band gap engineering, single crystal diamond, solid state lasers, optical detectors, electronics packaging, and any other related breakthrough technology.

BMDO 97T003 TITLE: Surprises and Opportunities

DESCRIPTION: BMDO recognizes that, at the leading edge of technology, surprises and opportunities may arise from creative minds and entrepreneurs. BMDO will consider proposals in other technologies that present an extraordinary opportunity for BMDO. But proposals will receive a preliminary screening that may reject them without full technical review as not offering enough of an extraordinary opportunity. This open call is for breakthrough technology with great market potential beyond the standards for the topics listed above.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Proposal Submission

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

The topics published in this solicitation are broad in scope. They were developed to bring the small business community and research partners together to meet the technological needs of today. DARPA has identified 10 technical topics, numbered **DARPA ST971-001** through **DARPA ST971-010** to which small businesses may respond in the fiscal year (FY) 97 solicitation. Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. Full topic descriptions, which originated from DARPA technical offices, are included.

DARPA Phase I STTR awards are limited to **\$99,000**, and are for approximately one (1) year efforts. Phase II STTR awards will be limited to \$500,000.

The responsibility for implementing DARPA's Small Business Technology Transfer (STTR) Program rests with the Office of Administration and Small Business (OASB). The DARPA SBIR/STTR Program Manager is Connie Jacobs. DARPA invites small businesses, in cooperation with a researcher from a university, an eligible contractor-operated federally-funded research and development center (FFRDC), or a non-profit research institution, to send proposals directly to DARPA at the following address:

DARPA/OASB/STTR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 522-1754

Additional information regarding DARPA and the DARPA STTR Program may be found on the World Wide Web DARPA Home Page at <http://www.darpa.mil>. During the Pre-Solicitation period (approximately 6 weeks before the solicitation opens) DARPA Program Managers may be contacted to discuss technical issues related to their topics. For a list of the Topic Points of Contact, please see the Pre-Solicitation release. E-mail is the most effective means of communicating with DARPA Program Managers. The e-mail address for all DARPA employees is (First initial of First Name)(Last Name) @darpa.mil. If you have trouble reaching a designated POC, please contact Connie Jacobs directly at cjacobs@darpa.mil.

STTR proposals submitted to DARPA will be processed by DARPA OASB and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the date of closing of this solicitation. Please note that **one original (with red appendices A and B) and 4 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1997 Phase I STTR
Checklist

- 1) Proposal Format
 - a. Cover Sheet - Appendix A (identify topic number) _____
 - b. Project Summary - Appendix B _____
 - c. Identification and Significance of Problem or Opportunity _____
 - d. Phase I Technical Objectives _____
 - e. Phase I Work Plan _____
 - f. Related Work _____
 - g. Relationship with Future Research and/or Development _____
 - h. Potential Post Applications _____
 - i. Key Personnel _____
 - j. Facilities/Equipment _____
 - k. Consultant _____
 - l. Prior, Current, or Pending Support _____
 - m. Cost Proposal (see Appendix C of this Solicitation) _____
 - n. Prior SBIR Awards _____
 - o. Agreement between the Small Business and Research Institution _____
- 2) Bindings
 - a. Staple proposals in upper left-hand corner. _____
 - b. **Do not** use a cover. _____
 - c. **Do not** use special bindings. _____
- 3) Page Limitation
 - a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. _____
 - b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. _____
- 4) Submission Requirement for Each Proposal
 - a. Original proposal, including signed **RED** Appendices A and B. _____
 - b. Four photocopies of original proposal, including signed Appendices A and B. _____
 - c. One additional photocopy of Appendices A and B only. _____

**Defense Advanced Research Projects Agency
FY1997 STTR Topic Description**

DARPA ST971-001 TITLE: Fractal and Wavelet Image Analysis for Region-of-Interest Classification

DESCRIPTION: The intent of this topic is to decrease computational needs in target recognition systems while improving region of interest determination.

A great deal of the natural environment seems to be fractal-based. This has been exploited in synthetic scene generation for a variety of civilian and military applications. Matched filtering has been used in digital and optical forms, for performing object recognition, for several years. A matched filter or a series of matched filters based on a "seed" fractal should be capable of removing fractal-based information from a scene, thereby making the identification or other processing of non-natural objects much more accurate.

Wavelet analysis of such diverse information as human speech and earthquakes has shown that this approach is excellent in determining where and/or when specific spectral bands occur -- especially in a relatively clutter-free environment. Wavelet analysis of images, after they have been filtered using the previous technique, should allow regions of interest, where a target may be found, to be located quickly and effectively.

PHASE I: Design wavelet basis functions. Perform computer simulations of fractal filtering and wavelet region-of-interest determination. Deliver computer code and results of simulations.

PHASE II: Design and build an optical system for laboratory demonstration. Test with actual imagery. Deliver optical system, system specifications, and test results.

COMMERCIAL POTENTIAL: The technique being pursued would allow for the search of large areas of natural terrain for man-made objects utilizing machine processing. The identification of man-made objects among naturally occurring environments has application to search large areas for search-and-rescue operations where "downed" aircraft are difficult to locate using the human eye,. Other civilian applications, which require large search areas for objects which normally should not be there, could also benefit from this technology.

DARPA ST971-002 TITLE: Development of Bacteriorhodopsin for Holographic Memory

DESCRIPTION: The intent of this topic is to develop, fabricate, and test a holographic memory for mass information storage using bacteriorhodopsin as the holographic recording medium. The holographic memory should be a page oriented system and provide access times better than current CD ROM technology and long hologram storage lifetime.

Bacteriorhodopsin has been investigated by researchers for years as a holographic recording material. Among its drawbacks for mass information storage has been the extremely short lifetime of the holograms. New variations in bacteriorhodopsin and methods of writing to it are making longer hologram lifetimes possible as well as thicker films which can store more information.

Bacteriorhodopsin could be used as a holographic memory for image based systems, such as optical correlators for target recognition and fingerprint identification devices. If it can be fabricated as a thick film, approaching one centimeter, and maintain optical quality, it would easily compete with silver halide, dichromated gelatin, and photorefractive crystals for dense holographic storage. A thick film would allow multiplexed holograms to be stored in the bacteriorhodopsin for fast parallel access.

PHASE I: Develop a model for a bacteriorhodopsin type that can be used for long term holographic storage. Fabricate and test a small sample of the material.

PHASE II: Fabricate a holographic memory utilizing a thick sample of the bacteriorhodopsin developed in Phase I. Test the memory and provide characterization of its capabilities and limitations.

COMMERCIAL POTENTIAL: This research addresses the development of new and innovative techniques for large data storage media with rapid retrieval capability. As such, there are many applications in the commercial world. It could conceivably replace the CD-ROM currently in use with smaller size, large capacity, more rapidly accessible, bulk storage devices. The use for such devices throughout the computer environment is extremely great.

DARPA ST971-003 TITLE: Innovative Research in the Areas of Embedded Capacitors for Electronic Circuits Based on Flexible Laminate Multichip Module/Printed Circuit Board (MCM-L/PCB) Formats

DESCRIPTION: Research and development of innovative materials and processes for embedding high-value capacitors in MCM-Ls and flexible circuit boards are sought as a replacement for discrete chip capacitors. Embedding capacitors provides several benefits to military electronics including improved reliability and performance, reduced area and weight, and more cost-effective assembly. Innovative approaches include, but are not limited to, loaded polymers, high K thin films, and unique planar geometries. Proposals must address issues associated with low-process temperatures, improved adhesion, and suitable breakdown voltages. High-reliability under a variety of environmental conditions for military applications should be considered when materials are selected.

PHASE I: Demonstrate feasibility of the proposed materials and processes by fabricating test structures and measuring capacitance per unit area, breakdown voltage, and frequency response. Reliability and adhesion experiments including 85/85 and mechanical flex are also expected during this phase. Detailed manufacturing techniques and commercialization strategies should also be well documented.

PHASE II: Demonstrate capacitors in a circuit application using manufacturable, low-cost processes. Document experimental results of reliability, performance, and cost benefits as compared to existing technology.

COMMERCIAL POTENTIAL: Development of embedded passives for flex circuit applications will have very large market potential as flex circuitry itself continues its growth. High-volume applications including portable, automotive, and military electronics require the reliability, performance, and low-cost that embedded capacitor technology offers.

DARPA ST971-004 TITLE: System Specification and Synthesis Language for Describing Single-IC Electronic Systems

DESCRIPTION: With new prototyped fabrication capabilities, we have the possibility of building complete systems in a single integrated circuit (IC) which contain a mixed complexity of digital hardware, integrated software, and other specialized technologies (analog/RF, MEMS, optics, fluidic processing, etc.). These true Systems on a Chip (SOC), while possible in the technology, cannot be built due to inadequate design capability. Specifically, there is a need to capture the stringent, over-specified requirements to allow a systematic analysis and search through a wide design space for a possibly unique (if any) solution. Complicating this further is the non-orthogonal direction that system requirements and manufacturing variances interact to create what seems to the designer to be an impossible-to-build system. Currently, we have no capability to capture the requirements and intended function of such systems in a computer sensible manner which can then be evolved into a manufacturable design implementation. Such "executable specifications" are the corner stone to allowing early, correct transfer of requirements to initial design and then providing for system synthesis into partitioned digital hardware (architecture), software (auto-coding), and unique technology solutions (RF and everything else). DARPA ETO is interested in research projects to define the new techniques required for systems specification and design in this area which would enable true systems on chips to be designed and manufactured.

PHASE I: Analysis and taxonomy created of the unique specification requirements and synthesis techniques needed. Previous human-computer design interface concepts studied and their applicability to the identified system requirements investigated.

PHASE II: New specification method and synthesis constraints developed. Concepts validated via a prototype implementation that interfaces to existing lower level digital hardware, software, and RF/MEMS tools.

COMMERCIAL POTENTIAL: The pioneer of a good capability in this area would have the potential to create a new market for systems on a chip (SOC) Electronic Systems Design (ESDA) tools using mixed technology. This is especially a necessity for the consumer portable, wireless design market. Such wireless systems are also crucial to building the sensor and information processing capabilities needed for advanced military capability; especially in small unit operations. The need for tools in this ESDA area is expected to grow dramatically over the next five years as companies look for ever increasing ways to develop highly integrated products quickly. Applying systems synthesis techniques to the total systems design of mixed technology systems is required to enable the use of the integrated systems we can now potentially manufacture.

DARPA ST971-005 TITLE: Collimation Development for Improved Efficiency of X-Ray Sources

DESCRIPTION: The overall efficiency of an x-ray point source for x-ray lithography steppers will be improved with the addition of a collimator between the x-ray source and the mask. Several design approaches for such collimators have been suggested. These approaches include capillaries, nested cones, microchannel plates, and graded multilayers on conic surfaces. The collimator design should be optimized for nominal 1.1 nm wavelength x-rays from a laser plasma point source. The design should address issues such as field size, divergence, gain, uniformity, cost of ownership, and integration with the stepper.

PHASE I: Prepare a design and planned fabrication approach to meet the needs for a lithography tool for production of semiconductor devices with 0.13 micron design rules. This should include ray trace analyses showing how the design meets the desired design parameters.

PHASE II: Build and test a prototype, followed by evaluation and alteration of design, and then fabrication of a second, more optimized structure.

COMMERCIAL POTENTIAL: X-ray lithography is a leading lithography candidate to succeed optical lithography. The current market for leading edge lithography tools is in the range of 500-1000 tools annually. The point source tool is preferred over the synchrotron x-ray source because of reduced capital investment, ease of ramping up to full production, and the absence of potential plant shutdown due to synchrotron failure. A good collimator design will improve productivity of the point source tool through increased effective fluence at the mask (wafer throughput) and improved design tolerance to geometric effects (overlay).

DARPA ST971-006 TITLE: Nanoprobes for Advanced Device Processing and Diagnostics

DESCRIPTION: The march of progress for microcircuits on silicon wafers is marked by two central themes: 1) shrinking the width of the lines, and 2) increasing the wafer size. As one continues to shrink the linewidth, one encounters the optical barrier. Progress beyond that limit will require a nonoptical lithographic system. Part of the objective of this program would be to develop a nanoprobe approach to lithography that begins where optical lithography leaves off, and extends, almost without limit, to the line that is only a few atomic diameters in width.

Potentially, such tools as the atomic force microscope (AFM) and/or scanning tunneling microscope (STM) demonstrate to be tools for lithography to 0.1 micrometer dimensions and better. This region is currently inaccessible to optical and e-beam lithographic techniques. These tools on the other hand are capable of atomic level resolution and are surprisingly easy to operate in the nanometer resolution regime. This reduced scale opens up a new area of device physics and technology. The end objective is to demonstrate the utility of high-throughput nanoprobe-based lithography for submicron structures with an aim toward sub 100 nm structures. Entirely new families of quantum devices can potentially be processed onto existing chips with this technique.

Concurrently, as we go to smaller device structures, there is a need for diagnostic tools. To gain a more complete understanding of experimental submicron and nanoelectronic devices as well as to characterize existing high-density CMOS circuits, one needs to probe the local time- or frequency-dependent electrical fields using such techniques which have been classified under the name of AC scanning force microscopy (ACSFM). Scanning microscopes offer substantially higher spatial resolution than more standard techniques; measurements of >100Ghz signals on field-effect transistors having been reported. The end objective is to develop diagnostic tools, primarily for the sub 100 nm structures, both in the spatial and temporal regime.

PHASE I: Aim is to develop a nanoprobe lithographic system and/or nanoprobe-diagnostic-tools for submicron structures. Objective is to define the operational criteria that will allow the STM/AFM or related technique to become an effective and competitive high throughput tool to current device processing equipment and/or define and develop diagnostic 'nano-tools' which will enhance the ability to characterize advanced device structures well below 0.1 micrometer. Proof of principle is desired in the form of experimental results.

PHASE II: Objective is to construct/fabricate the nanoprobe diagnostic tools and qualify them through characterization of micro- and nanoelectronic devices. And/or construct/fabricate high throughput STM/AFM (or related techniques) that would be retrofitted into existing processing equipment. The device will be qualified by the production of submicron and/or quantum device structures on the surface of silicon and results compared to current industry throughput.

COMMERCIAL POTENTIAL: The program could possibly accelerate the utilization of quantum devices in advanced electronic circuits. The nanoprobe tools would allow for new commercial diagnostic equipment and would increase the fundamental understanding of extremely small structures: electronic, optical, and mechanical. This technology may leverage the development of maskless lithography which would be of benefit to the commercial integrated circuits industry, which has annual world sales in the billions of dollars.

DARPA ST971-007 TITLE: Haptic Input for Surgical Simulators in Virtual Environments

DESCRIPTION: Current first generation surgical simulators using virtual environments do not have adequate input devices for providing the sense of touch. Surgery, combat casualty care, and other medical procedures are dependent upon the sense of touch; therefore, accurate input devices are needed. The device must be operable on a workspace of at least 1 cubic meter, have rapid response time (less than 100 millisecond), and be very high bandwidth. For tactile input there must be 1mm two-point discrimination; for edge detection there must be less than 1mm position accuracy. All modalities will be considered, including those not typically considered haptic, such as vibration, temperature, etc. Studies discovering values, physiologic limitations, emulation, and synesthesia (substitution of one sensory input for another) for haptic input are also entertained.

PHASE I: Provide feasibility study or definition of requirements for novel approaches to haptic input devices. The devices must be unencumbering, high bandwidth, and intuitive for the user.

PHASE II: Develop a prototype device with control software.

COMMERCIAL POTENTIAL: A haptic device for surgical applications can be commercialized for surgical simulators, but is applicable for any form of simulator in any industry application, such as heavy equipment engineers, loading operators, and newer generation military simulators. In addition, by scaling down accuracy, cost can be driven down to a point where commercialization for entertainment is practical. Millions of joysticks and other input devices are sold annually.

DARPA ST971-008 TITLE: Wide Area Mine Field Surveillance Using Low Frequency Resonance and Structural Acoustics

DESCRIPTION: Current approaches to detecting mines in shallow water focuses on the detection of a single mine-like object. This approach inherently leads to slow sweep rates, and close range surveillance. A novel approach is proposed in this STTR topic, mainly the detection of a mine field, that is the detection of numerous mine-like objects in the water column. The intent is to ascertain the presence or absence of substantial mining in a given region. Detecting fields, as opposed to individual mines, allows for surveillance at greater ranges, exploiting the coherent integration gain of numerous echoes. The approach prescribed is as follows: 1) sonify with a low frequency active source (to exploit mine resonances), 2) receive using a multistatic array of bottom mounted or towed array sensors, and 3) perform data fusion, exploiting structural acoustics, from the receiver arrays.

This STTR topic desires the coupling of the optimal processing techniques being primarily developed in the academic community, the current low frequency active sonars in the underwater surveillance community, and the multi-static acoustic processing technology being developed by the Navy laboratories and contractors. The outcome of this STTR topic will be the core signal processing technology for expanding the role for maritime surveillance assets to mine field surveillance.

PHASE I: Generation of digitally simulated mine fields, using data testbeds from actual mine measurements. Development of hypothesis testing procedures, and validation of detection ranges 10x further than available for individual mines in isolation.

PHASE II: Test range deployment of a small scale mine field, assessment of surveillance performance, and design of a real-time signal processing architecture.

COMMERCIAL POTENTIAL: Mine field detection can be applied to the detection of traps, baits, and other fishing artifacts. As such, it can be employed for the enforcement of fishery regulations.

DARPA ST971-009 TITLE: Low-Cost, Miniature Unattended Sensor Systems

DESCRIPTION: Research and development leading to the design and demonstration of novel, low-power, low-cost, miniature, internetted unattended sensor systems for the detection, localization, and classification of air, ground, and shallow water time critical targets are required. Efforts may address individual miniature sensor systems, such as acoustic, seismic, chemical, environmental, orientation, geolocation, imaging, and magnetic systems; however, multi-sensor systems with local signal processing, data fusion and an internetted communications capability, are also of interest. Low-power, autonomous wake-up, and commanded wake-up capabilities for these unattended systems are required. Efforts of interest also include low-power, extended life, high-resolution sensors, efficient real-time feature based classifiers, environmental models for real-time transformation of sparse sensed data to predictions of area weather and propagation related parameters, decision aids to enable optimum configuration and processing of data from sensor arrays, and technologies to precision air deliver individual and arrays of unattended sensor systems from either tactical aircraft, unmanned air vehicles, mortars, and artillery shells, including packaging of these sensor systems in submunition sized configurations compatible with area denial missile systems such as MLRS and ATACM systems. Parameters of interest that will be utilized to evaluate proposed sensor concepts are projected cost, size, weight, reconfigurability through modular design, power consumption, covert operations, and detection, localization and classification performance. Aggregate metrics, such as dollars-per-kilometer squared detection coverage-hours of life without battery change, will be utilized to compare proposed concepts. Parameters of interest that will be utilized to evaluate proposed aircraft and unmanned air vehicle delivery system concepts are projected cost, size, weight, stowage capability, altitude and delivery range capability, precision of delivery (CEP), and, for earth penetrating concepts, the capability to penetrate in varying soil conditions while still maintaining communications and in-situ sensing capability after delivery.

PHASE I: Concept description and initial design of sensor related system with clear description and quantification of key predicted performance parameters. A sensitivity analysis that indicates the predicted performance of alternate proposed system configurations, including identification of highest risk aspects of the proposed design, is also required. Risk mitigation demonstrations and/or simulations of key high-risk aspects of the proposed design, to demonstrate proof of concept, is also required.

PHASE II: Final design and demonstration of the proposed sensor related system, with post-demonstration analysis sufficient to demonstrate proof of performance for the proposed system. Complete design and demonstration documentation must be delivered.

COMMERCIAL POTENTIAL: Work performed under this topic may be applicable to commercial security and surveillance technologies, urban and commercial architectural planning and simulation, and robotic vehicle systems.

DARPA ST971-010 TITLE: Novel Imaging Concepts

DESCRIPTION: The advance of electronic imaging systems has opened up new possibilities for imaging systems. These include the intelligent use of spatial, spectral, polarimetric and temporal characteristics of the image field to "synthetic" images which combine high intelligibility with high contrast for interesting objects or phenomena. While considerable progress has been made in this area, the challenge is to develop these capabilities in compact, affordable packages.

PHASE I: Concept description, including the identification of key underlying technology and scientific issues, and an initial design of an imaging sensor system with clear description of algorithms, models, approach to parallelism, and limits of scalability. Quantification of key predicted performance parameters and a sensitivity analysis that indicates the predicted performance of alternate proposed system configurations, including identification of highest risk aspects of the proposed design, are also required. Risk mitigation demonstrations and/or simulations of key high-risk aspects of the proposed design, to demonstrate proof of concept, is also required.

PHASE II: Final design and demonstration of the proposed sensor related system, with analysis sufficient to demonstrate proof of performance for the proposed system. Complete design and demonstration documentation must be delivered, in addition to demonstration hardware.

COMMERCIAL POTENTIAL: Technologies developed under this topic may have potential civil applications including remote sensing, security systems, robotic vision, and materials/process control.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy STTR program is with the Office of Naval Research. The Navy STTR Program Manager is Mr. John Williams. Inquiries of a general nature may be brought to the Navy STTR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. John Williams
ONR 362 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-0342

All STTR proposals submitted in response to a Navy STTR topic should be sent to the above address.

This solicitation contains five technical topics that meet the mission requirements of the Navy and PL 102-564 to which small R&D businesses together with a research institution may respond. The Navy will provide potential awardees the opportunity to reduce the gap between phases I & II by providing up to \$70,000 Phase I proposal award and \$30,000 Phase I Option award. Only an awardee whose Phase II proposal has been recommended and selected for award will have the Phase I Option funded. Therefore, those who have finished or almost finished their Phase I should submit their Phase II proposal. The Phase II proposal should contain three elements: 1) a plan of how the proposer will commercialize the technology to the government and the private sector; 2) a Phase II work plan; and 3) a Phase II Option. At the end of the Phase II portion, a determination will be made by the Navy as to whether the proposer has satisfied the commercialization plan sufficiently for the government to fund the "Phase II Option" portion of the proposal. The Phase II Option should address the further R&D or test and evaluation aspects of the proposal. The total Phase II funding should not exceed \$500,000 with 80% going to the Phase II and 20% for the "option Phase II". Just as the Navy has set aside funding for "fast track" efforts in the SBIR Program, we will consider faster contract award for companies that identify third party funding and can obtain the cash in hand prior to award. Third party funds are described as those funds that come from venture capitalists, companies not connected with the STTR award government programs other than SBIR/STTR, or private investors not related to employees of the company, etc.

Selection for award of Phase I proposals is based upon technical merit and evaluation criteria contained in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded.

DEPARTMENT of NAVY
SMALL BUSINESS TECHNOLOGY TRANSFER PROGRAM SOLICITATION
TOPIC TITLES FY 1997

N97T001 Four dimensional (4-D) Atmospheric and Oceanographic Instrumentation.

N97T002 Autonomous Distributed Systems

N97T003 Environmentally Adaptive Broadband Sonars for ASW and MIW

N97T004 Remote Sensing, Algorithms, and Inexpensive Space Sensors

N97T005 Object Classification Sensors, Communications, and Position Reporting for Small Robotic Vehicles

DEPARTMENT of NAVY
SMALL BUSINESS TECHNOLOGY TRANSFER PROGRAM SOLICITATION
FY 1997

N97T001 TITLE: Four dimensional (4-D) Atmospheric and Oceanographic Instrumentation.

OBJECTIVE: Develop low-weight and low-volume instruments/sensors/techniques to autonomously measure atmospheric and/or oceanographic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain marine atmospheric and oceanographic variables (e.g., physical, chemical, optical, geophysical and biological) in 3-D space and time. The emphasis must be placed on (1) novel approaches and concepts for measuring a particular parameter(s) coherently in 4-D, (2) conducting these observations as autonomously as possible (i.e. for independent operation on Remotely Piloted Aircraft (RPA), Autonomous Underwater Vehicles (AUV's), or Buoys), and (3) providing a significant reduction in instrument weight and volume without reducing fidelity or resolution as compared to current state-of-the-art systems. The instruments solicited can utilize active and/or passive measurement approaches covering either acoustic or E/M frequencies to support remote sensing or in-situ observations. Full column depth capabilities are desired in instrumentation planned for subsurface use. Innovative imaging systems are encouraged for various sea and near-shore parameters, and for geological features within the shallow sea floor. These systems might utilize high resolution, digital techniques with high frame rates and tunable filtering. 3-D sub-bottom swath imaging capability is also desired, from which volume scattering strengths of sediments and buried objects, along with size and depth of buried objects, might be obtained.

PHASE I: Provide both an exact description of the parameter to be measured include accuracy and coherence along with the design concept for achieving the measurement.

PHASE II: Produce a viable prototype system and demonstrate it's ability to support in field measurements from an operating autonomous research vehicle.

PHASE III: Transition the technology to scientists in the atmospheric, oceanographic and environmental monitoring research communities, and operational DOD systems.

COMMERCIAL POTENTIAL: New instruments can be used in a wide variety of commercial environmental monitoring systems.

N97T002 TITLE: Autonomous Distributed Systems

OBJECTIVE: Enable the development of affordable, high performance, mobile and stationary, autonomous distributed systems for surveillance and measurement of the Littoral environment.

DESCRIPTION: The focus of this STTR topic is to stimulate bold new concepts for significantly improved hardware and software components of autonomous distributed systems, with emphasis on flexibility, affordability, performance, and operability. Autonomous in this context means that the units of the distributed system are not mechanically linked by communication or power cables. Examples of interest are: fleets of UUVs measuring the ocean environment or searching for mines, fleets of UAVs performing coastal surveillance or measuring the atmosphere, packs of ambulatory robots exploring the ocean floor for mines or measuring the benthic properties, fields of fixed sensor nodes which detect and track submarines and surface ships for surveillance and cooperative engagement. These systems will be deployed from submarines, surface ships and aircraft. Hardware concepts of interest include: light weight, low speed, medium range vehicles (UUVs and UAVs, characteristics of a UUV might be less than 200 kg in air, less than 250 cm/s max speed, range greater than 500 km.); long-life and compact power supplies; methods of extracting power from the environment; underwater acoustic and in-the-air RF communication links; acoustic and electro-magnetic remote sensors; contact sensors to measure the METOC environment; innovative methods of packaging. Software concepts of interest include: fault tolerant networking; distributed control algorithms; data compression methods; signal processing algorithms; and multi-sensor data fusion. In all cases the drive is toward smaller, cheaper, less power consuming, more robust components.

Phase I: Develop a conceptual design of the proposed component. State-of-the-art methods should be used to engineer robust, lightweight, reproducible vehicles and components at the lowest possible cost. This design and supporting documentation should be sufficient to convince qualified engineers that the proposed concept is technically feasible. It should include a concept of operations.

Phase II: Produce and demonstrate performance of a working model of the proposed vehicle or component. Construct the model to demonstrate performance in the most cost effective manner. Demonstrate performance in such a way as to convince qualified engineers that the proposed component is capable of meeting requirements in an operational environment. Cost trade-offs in production quantities should be analyzed.

Phase III: Team with the manufacturer of one of the Navy's autonomous distributed systems to integrate the component into future generations of the system. Team with manufacturers of commercial autonomous distributed systems to integrate the component into these products.

COMMERCIAL POTENTIAL: The commercial market for many of the components necessary for autonomous distributed systems is large. Network-class UUVs and UAVs are needed for environmental sampling. Network-class UUVs are needed for underwater salvage. Fault tolerant networking and control of distributed computing systems is needed for automated banking systems, electronic stock markets, air traffic control, and electrical power distribution. Longer endurance, cheaper batteries are needed for a host of commercial applications.

References: Thomas B. Curtin, James G. Bellingham, Josko Catipovic and Doug Webb, "Autonomous Oceanographic Sampling Networks", *Oceanography*, Vol. 6, No. 3, pp 86-94, 1993; John S. Langford and Kerry A. Emanuel, "An Unmanned Aircraft for Dropwindsonde Deployment and Hurricane Reconnaissance", *Bulletin American Meteorological Society*, Vol. 74, No. 3, pp 367-375, March 1993

N97T003TITLE: Environmentally Adaptive Broadband Sonars for ASW and MIW

OBJECTIVE: Develop innovative hardware for producing broad-band acoustic signals and signal processing technologies that will enable Anti-Submarine Warfare (ASW) and Mine Warfare (MIW) sonar systems to adapt to harsh shallow water environments.

DESCRIPTION: A "shallow water" environment for sonar is defined to be where losses associated with boundary interactions dominate the propagation from the transmitter to the target and the target to the receiver. The bottom interaction depends on the local bottom slope, constitution, and construction. Surface interactions depend on sea-state and wind velocity. In bistatic and multistatic operations, the receiver(s) and the transmitter(s) are typically in separate locations. Local targets of opportunity and local bathymetric features along with direct path transmissions from the transmitter to receiver, can provide information to aid in the estimation of reverberation levels, clutter maps, multi-path effects, normal-mode excitations and ray paths. Estimation of these parameters can aid in the selection of the optimum sonar system operating parameters. In addition, signal processing procedures such as multipath recombining can use this knowledge to improve detection and tracking performance. Transducer designs proposed should be capable of producing a variety of controlled wave forms over a very wide frequency band. Projects selected under this topic will identify and investigate approaches to use tactically feasible in-situ measurements of the acoustic environment to determine and update operational parameters of ASW and MIW systems, including both wet-end (acoustic sources and receivers) and dry-end (signal processing) parameters. Teaming between the small business partner and the research institution should allow investigation of innovative transducer concepts, innovative manufacturing approaches, innovative signal processing techniques, environmental estimation and modeling, and sonar system design.

PHASE I: Develop a detailed design for an innovative acoustic projector, including assembly drawings, modeling of predicted performance, and a plan for manufacture with detailed cost estimates. Conduct a design review for the Navy. Develop a set of algorithms useful in determination of relevant shallow water sonar parameters. Analyze their performance based on simulated data such as that produced by state-of-the-art environmental models. Investigate preliminary designs for environmentally adaptive systems and potential operational techniques.

PHASE II: Build a prototype acoustic projector of the design developed in PHASE I, demonstrating its innovative features. Demonstrate the low cost manufacturing concept. Test the transducer at the Navy's test facility at Seneca Lake, NY. Investigate selected algorithms using recorded sea data (to be furnished GFI) for regions of known propagation conditions and for their ability to mitigate the problems which can be associated with shallow water sonar.

Conduct sea tests of the broadband acoustic projector, using the selected algorithms and environmentally adaptive system techniques as appropriate and feasible, in conjunction with other ONR exploratory development projects. Candidate Navy systems will be identified for transition of algorithms and techniques developed under this effort.

PHASE III: Build an improved prototype acoustic projector aimed at a specific Navy tactical application, showing advantages in cost or performance over the existing technology used or being considered for that application. Transition technology to an ongoing Navy acquisition program. Integrate successful algorithms into environmental models used for performance prediction purposes, and demonstrate techniques for in-situ environmental adaptation of ASW or MIW systems at-sea. Define a transition path to fleet systems.

COMMERCIAL POTENTIAL: The technology developed should have applicability to a variety of commercial needs. Commercial potential is dependent on specific problems addressed but include: off-shore petroleum and mineral exploration; ocean bottom mapping; underwater obstacle avoidance; underwater inspection services including environmental assessment; non-destructive evaluation of structures, and medical imaging technology; and enhanced underwater acoustic communications, for example, among divers.

REFERENCES:

1. D. R. Knobles and R. A. Koch, "A Time Series Analysis of Sound Propagation in a Strong Multipath Shallow Water Environment With An Adiabatic Normal Mode Approach", IEEE, Trans. Ocean Eng., Vol. 21, 1-13, Jan. 1996.

N97T004TITLE: Remote Sensing, Algorithms, and Inexpensive Space Sensors

OBJECTIVE: To develop novel means of remotely sensing ocean, terrestrial, atmosphere, and space environments by airborne or spaceborne sensors and associated processing algorithms; and to investigate new sensor approaches to the detection of targets in the littoral area.

DESCRIPTION: Technological advances offer new opportunities to develop earth and space environment sensors which are inexpensive yet remarkably capable. These advances include a variety of new sensor approaches being developed and evaluated for airborne detection of targets such as mines in the littoral area. At the same time, signal processing algorithms play an increased role in extracting increased engineering capabilities and novel geophysical parameters from sensors. This effort seeks proof of concept science developments which form the basis for new remote sensing techniques. Active and passive sensors and arrays in microwave or electrooptical bands, and algorithms for new or existing sensors will be considered. Preference will be given to littoral applications.

Phase I: Develop a system design which provides detail on the sensing method and construction approach. Simulation of sensor performance for relevant environmental scattering, emission, or propagation parameters should be a key element of the design.

Phase II: Construct the sensor instrumentation or sensing algorithm from the Phase I design. Conduct relevant laboratory and field performance tests of sensor or algorithm demonstrating achievement of design specifications.

Phase III: Conduct follow-on experimental campaigns demonstrating the full range of sensor or algorithm performance over a wide range of environmental conditions, to include ocean, terrestrial, littoral, atmospheric and space environments. Demonstrate new remote sensing capability by analysis of sensor data compared to in situ environmental data for the same parameter.

COMMERCIAL POTENTIAL: Inexpensive, proof-of-concept environmental sensors have become their own private sector industry supporting earth resources, geographical information systems, environmental remediation survey equipment, commercial scientific instruments.

N97T005TITLE: Object Classification Sensors, Communications, and Position Reporting for Small Robotic Vehicles

OBJECTIVE: Develop low power, low cost object detection/classification sensors and communications/mapping systems for use in swarming systems of small robotic vehicles deployed on surveillance and/or threat neutralization missions in the surf zone and/or on land.

DESCRIPTION: Emerging surf zone and beach reconnaissance and mine and/or obstacle neutralization concepts involve the use of many small robotic vehicles to find and mark the location of or destroy threats to the Naval amphibious landing forces. Threats may be on the sea floor or on land, partially or fully buried, or may be suspended in the water column. Prototype vehicles and search strategies have been developed and tested. Autonomous object detection and classification technologies, compatible with the many small robotic vehicles concepts and the surf zone and beach environments, are now necessary to further develop the swarming robotic vehicles systems. In order to use the information gathered by the robots, the vehicles must have the capability of periodically reporting back their location, search status, vehicle status, etc. to the amphibious task force (eg. either singly or via a locally located special purpose platform). This implies a local reporting system capable of at a minimum 8 bits per second, local transmission ranges up to several hundred meters, and long range transmission to command posts of up to 300 kilometers. In some scenarios this information is used to construct a map of threats in the operational area which may be neutralized by other means. In other scenarios the vehicles affect the neutralization on command. In many scenarios the communications must be covert. In all situations vehicle sensing, positioning, and communications subsystems must be of a size, power requirement, and cost compatible with the many small robotic vehicles concept. Proposals need not consider all aspects of the problem but may address sensing, communications and mapping, and the land and water environments separately.

PHASE I: This part of the investigation will entail defining the problem and assessing the capability of current or emerging sensor, processing, navigation, and communications technologies to accomplish the objective on land and/or in the surf zone. It will be necessary to become familiar with the current state of development of the many small robotic vehicles concepts and candidate vehicles. An initial design of a candidate processor/sensor system and/or communication and mapping system should be addressed. Communications systems should plan for at least 100 vehicles periodically reporting data.

PHASE II: This part of the investigation will entail final design, fabrication, and laboratory testing and evaluation of the sensor/ processor system and/or communication/mapping system, installation of the system(s) on a prototype robotic vehicle and testing and evaluation of performance against targets placed in a natural environment. Communications and mapping systems should demonstrate short range and long range capabilities which allow the command post to know the location, dispersion and status of multiple (100 or more) vehicles relative to the task force location.

PHASE III: Transition of the sensor/processing system and/or communications/mapping system to Navy reconnaissance and neutralization systems for mine counter measure, surf zone breaching, and explosive ordnance disposal missions. Appropriate detection/classification systems may be transitioned to currently employed law enforcement platforms or integrated to current remediation efforts ongoing in the Department of Defense

COMMERCIAL POTENTIAL: Commercial applications include environmental monitoring and prediction, marine salvage, environmental cleanup, demining and law enforcement. The many industries associated with these activities will benefit.

REFERENCES:

1. Curtin, et al., 1993. Autonomous Oceanographic Sampling Networks. *Oceanography*, 6(3): 86-94.
2. U.S. Environment Center, "Unexploded Ordnance Advanced Technology Demonstration Program at Jefferson Proving Ground (Phase I)", Dec 1994, Report No. SFIM-AEC-ET-CR-94120.
3. U.S. Department of State, "Hidden Killers, The Global Landmine Crisis", Dec 1994, Department of State Publication 10225.
4. U.S. Naval Mine Warfare Plan, Third Edition, Fiscal Year 1996-1997 Programs, Appendix D.
5. Bottoms, A.B., Eagle, J. And Bayless, H., 1995. Proceedings of the Autonomous Vehicles in Mine Countermeasures Symposium, April 4-7, 1995, Naval Postgraduate School, Monterey, CA.